

Nature and Properties of Waves

PS-7 The student will demonstrate an understanding of the nature and properties of mechanical and electromagnetic waves.

PS-7.2 Compare the nature and properties of transverse and longitudinal/compressional mechanical waves.

Taxonomy level: 2.6-B Understand Conceptual Knowledge

Key Concepts:

Mechanical waves: Transverse waves, Longitudinal/Compressional waves

Wave properties: Crest, Trough; Compression, Rarefaction

Previous/Future knowledge: In the 8th grade students distinguished between mechanical and electromagnetic waves (8-6.2), and explained how scientists use seismic waves—primary, secondary, and surface waves—to determine the internal structure of Earth (8-3.2). In Physical Science students will consider particle movement within the medium to compare transverse and longitudinal waves.

It is essential for students to

- Understand that there are two types of waves, electromagnetic and mechanical.
 - Electromagnetic waves may travel through a medium but do not need a medium for transmission. Electromagnetic waves transfer energy through a medium or space. (Electromagnetic waves will be addressed in PS-7.5)
 - *Mechanical waves* must have a medium through which to move.
 - Mechanical waves transfer energy through the particles of a medium.
 - The particles of the medium move back and forth, but the wave (energy) itself is transmitted progressively from one place to another.
- Understand the nature of transverse and longitudinal mechanical waves.
 - In a **transverse wave**, as the wave (energy) moves through the medium, the direction of the back and forth motion of the particles is perpendicular to the direction that the wave is moving.
 - Examples of transverse mechanical waves might include: Some “slinky” spring waves, secondary earthquake waves, and waves in the string of stringed instruments such as a guitar.
 - In a **longitudinal wave** (also called compressional), as the wave (energy) moves through the medium, the direction of the back and forth motion of the particles is parallel to the direction that the wave is moving.
 - Examples of longitudinal mechanical waves might include: Some “slinky” spring waves, sound waves, primary earthquake waves, shock waves from a sonic boom or explosion, and ultrasonic waves.
- Understand the wave properties of transverse waves - crests and troughs, and of longitudinal waves - compressions and rarefactions.
 - In a **transverse wave** the point of maximum displacement of the particles in a medium from the equilibrium position is called a *crest* or *trough*.
 - In a **longitudinal wave** the particles of the medium are pushed closer together to form a high pressure area called a *compression* and spread out to form a lower pressure area with fewer particles called a *rarefaction*.
- Understand that some waves cannot be classified as transverse or longitudinal waves
 - The motion of the particles in some waves can be described as circular. Surface water waves fall into this category.
 - In torsion waves the motion of the particles is a twisting motion.

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Misconception:

Students sometimes think that waves are one or two-dimensional. Many waves such as sound and light waves are often three-dimensional.

It is not essential for students to describe the motion of particles in waves that are not transverse or longitudinal waves, such as torsion waves or water surface waves.

Students should, however, be able to recognize these waves as non-examples if the motion of the particles in the medium is described.

Assessment Guidelines:

The objective of this indicator is to compare the nature and properties of transverse and longitudinal waves, therefore, the primary focus of assessment should be to give similarities and differences between these waves with regard to the movement of the particles in the medium, the direction that the wave moves, and the properties of the waves.

In addition to *compare*, students should be able to

- Exemplify or Illustrate transverse and longitudinal waves - give examples or draw or label illustrations which depict the motion of particles and the motion of the wave;
- Classify waves by determining which of the two types of waves (transverse or longitudinal) is being described based on the motion of particles and the motion of the wave;
- Summarize transverse and longitudinal mechanical waves by giving major points about the characteristics of these waves.